

WHAT IS CLAIMED IS:

1. A filtering apparatus calculating a median of N pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd number not smaller than 3) of a digitized image, comprising:

receiving means for receiving said N pixel values;

5 removing means for removing, from said received N pixel values, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and

10 sorting means for outputting, among $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values by said removing means, first pixel value as sorted in accordance with said prescribed order as said median.

2. The filtering apparatus according to claim 1, wherein said prescribed order is either ascending order or descending order.

3. The filtering apparatus according to claim 1, wherein said receiving means has

dividing means for dividing said received N pixel values into K groups each consisting of K pixel values, and

5 group sorting means, for each of said K groups obtained by the division by said dividing means, for receiving and sorting the pixel values of the group in accordance with said prescribed order and outputting to said removing means;

10 said removing means has a plurality of cascade-connected pixel removing units for removing $(N-1)/2$ pixel values from said N pixel values; each of said pixel removing units has

a determining unit determining, among first pixel values in accordance with said prescribed order of respective ones of said K groups applied, at least one first and following pixel values in accordance with the prescribed order, and

15 a shift storing unit receiving, temporarily storing and outputting

said pixel values of said K groups; and

20 said shift storing unit removes, in said group including said pixel value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

25 4. A filtering apparatus calculating a median of N pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd number not smaller than 3) of a digitized image, comprising:

30 receiving means for receiving said N pixel values;
removing means for removing, from said received N pixel values, $((N-1)/2+2)$ to Nth pixel values as sorted in accordance with a prescribed order;
and

sorting means for outputting, among $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values by said removing means, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as said median.

5. The filtering apparatus according to claim 4, wherein said prescribed order is either ascending order or descending order.

6. The filtering apparatus according to claim 4, wherein said receiving means has

dividing means for dividing said received N pixel values into K groups each consisting of K pixel values, and

5 group sorting means, for each of said K groups obtained by the division by said dividing means, for receiving and sorting the pixel values of the group in accordance with said prescribed order and outputting to said removing means;

10 said removing means has a plurality of cascade-connected pixel removing units for removing $(N-1)/2$ pixel values from said N pixel values;
each of said pixel removing units has

a determining unit determining, among first pixel values in accordance with said prescribed order of respective ones of said K groups applied, at least one first and following pixel values in accordance with the prescribed order, and

15 a shift storing unit receiving, temporarily storing and outputting said pixel values of said K groups; and

said shift storing unit removes, in said group including said pixel value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

7. A filtering apparatus calculating, where a plurality of local areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, comprising:

5 receiving means for receiving pixel values of said prescribed area and for outputting, for each of said plurality of local areas, N pixel values included in the local area; and

median extracting means corresponding to each of said plurality of local areas; wherein

10 said median extracting means has

removing means, receiving from said receiving means N pixel values included in corresponding said local area, for removing, from the input pixel values, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order, and

15 sorting means for outputting, among $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values by said removing means, first pixel value as sorted in accordance with said prescribed order, as said median.

8. The filtering apparatus according to claim 7, wherein said prescribed order is either ascending order or descending order.

9. The filtering apparatus according to claim 7, wherein
said receiving means has
dividing means for dividing said received pixel values of said local
areas into a plurality of groups each consisting of K pixel values, and
5 group sorting means, for each of said plurality of groups obtained by
the division by said dividing means, for receiving and sorting the pixel
values of the group in accordance with said prescribed order and outputting
to said removing means corresponding to said local area to which the group
belongs;
10 said removing means has a plurality of cascade-connected pixel
removing units for removing $(N-1)/2$ pixel values from said N pixel values;
each of said pixel removing units has
a determining unit determining, among first pixel values in
accordance with said prescribed order of respective ones of said K groups
15 applied, at least one first and following pixel values in accordance with said
prescribed order, and
a shift storing unit receiving, temporarily storing and outputting
said pixel values of said K groups; and
said shift storing unit removes, in said group including said pixel
20 value determined by said determining unit, said determined pixel value
from said pixel values of the stored group, and shifts order of the second
and the following pixel values remaining after the removal in accordance
with said prescribed order before outputting.

10. A filtering apparatus calculating, where a plurality of local
areas including N pixel values of $K \times K$ (K is an odd number not smaller
than 3) are arranged overlapped with each other in a prescribed area of a
digitized image, a median of N pixel values of each of the local areas,
5 comprising:
receiving means for receiving pixel values of said prescribed area and
for outputting, for each of said plurality of local areas, N pixel values
included in the local area; and
median extracting means corresponding to each of said plurality of

10 local areas; wherein
said median extracting means has
removing means, receiving from said receiving means N pixel values
included in corresponding said local area, for removing, from the received
pixel values, $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with
15 a prescribed order, and
sorting means outputting, among $(N-(N-1)/2)$ pixel values remaining
after removal of the pixel values by said removing means, $(N-(N-1)/2)$ th
pixel value as sorted in accordance with said prescribed order, as said
median.

11. The filtering apparatus according to claim 10, wherein
said prescribed order is either ascending order or descending order.

12. The filtering apparatus according to claim 10, wherein
said receiving means has
dividing means for dividing said received pixel values of said local
areas into a plurality of groups each consisting of K pixel values, and
5 group sorting means, for each of said plurality of groups obtained by
the division by said dividing means, for receiving and sorting the pixel
values of the group in accordance with said prescribed order and outputting
to said removing means corresponding to said local area to which the group
belongs;
10 said removing means has a plurality of cascade-connected pixel
removing units for removing $(N-1)/2$ pixel values from said N pixel values;
each of said pixel removing units has
a determining unit determining, among first pixel values in
accordance with said prescribed order of respective ones of said K groups
15 applied, at least one first and following pixel values in accordance with said
prescribed order, and
a shift storing unit receiving, temporarily storing and outputting
said pixel values of said K groups; and
said shift storing unit removes, in said group including said pixel

20 value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

13. A data driven type information processing apparatus including operating means receiving a packet having at least a destination field storing destination information, an instruction field storing instruction information and data field storing data, for executing an operation in
5 accordance with a data flow program using the received packet, wherein said operating means has
filtering operation means for performing an operation in accordance with a median filtering instruction instructing calculation of a median of N pixel values arranged in a two-dimensional area of K*K (K is an odd
10 number not smaller than 3) of a digitized image, means for other operations, and branching means for outputting, based on said instruction information of said received packet, said received packet either to said filtering operation means or said means for other operations;
said filtering operation means includes
15 removing means for removing, from said N pixel values in said data field of said received packet, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order, and
sorting means for storing, among $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values by said removing means, first pixel value
20 as sorted in accordance with said prescribed order, as said median in said data field of said packet and outputting said packet.

14. The data driven type information processing apparatus according to claim 13, wherein
said prescribed order is either ascending order or descending order.

15. The data driven type information processing apparatus according to claim 13, further comprising:

program storing means for storing said data flow program including
a plurality of pieces of said destination information and a plurality of pieces
5 of said instruction information, receiving said packet, reading subsequent
said destination information and subsequent said instruction information
from said data flow program, storing the read information to said
destination field and said instruction field of the received packet,
respectively, and outputting the received packet;
10 pair data detecting means for receiving said packet output from said
program storing means, storing contents necessary to execute said
instruction information of said instruction field of the received packet and
outputting the received packet to said operating means; and
input/output control means for receiving said packet output from
15 said operating means, and outputting to the outside or to said program
storing means.

16. A data driven type information processing apparatus including
operating means receiving a packet having at least a destination field
storing destination information, an instruction field storing instruction
information and data field storing data, for executing an operation in
5 accordance with a data flow program using the received packet, wherein
said operating means has
filtering operation means for performing an operation in accordance
with a median filtering instruction instructing calculation of a median of N
pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd
10 number not smaller than 3) of a digitized image, means for other operations,
and branching means for outputting, based on said instruction information
of said input packet, said received packet either to said filtering operation
means or said means for other operations;
said filtering operation means includes
15 removing means for removing, from said N pixel values in said data
field of said received packet, $((N-1)/2)+2$ to Nth pixel values as sorted in
accordance with a prescribed order, and
sorting means for storing, among $(N-(N-1)/2)$ pixel values remaining

20 after removal of the pixel values by said removing means, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median in said data field of said packet and outputting said packet.

17. The data driven type information processing apparatus according to claim 16, further comprising:

5 program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10 pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

15 input/output control means for receiving said packet output from said operating means, and outputting to the outside or to said program storing means.

5 18. A data driven type information processing apparatus including operating means receiving as a packet having at least a destination field storing destination information, an instruction field storing instruction information and data field storing data, for executing an operation in accordance with a data flow program using the received packet, wherein said operating means has

10 filtering operation means for performing an operation in accordance with a median filtering instruction instructing, where a plurality of areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, calculation of a median of N pixel values of each of the areas, means for other operations, and branching means for outputting, based on said instruction information

of said received packet, said received packet either to said filtering operation means or said means for other operations;

15 said filtering operation means includes

receiving means for inputting pixel values of said plurality of local areas of said data field of said received packet, and outputting, for each of said plurality of local areas, a packet having N pixel values included in the local area stored in the data field, and

20 median extracting means corresponding to each of said plurality of local areas; and

 said median extracting means includes

removing means, receiving from said ~~input~~^{receiving} means a packet storing N pixel values included in corresponding said area, for removing, from the
25 input pixel values, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order, and

 sorting means for extracting, among $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values by said removing means in the data field of said packet, first pixel value as sorted in accordance with said
30 prescribed order, as said median, storing the median in said data field of said packet and outputting the packet.

19. The data driven type information processing apparatus according to claim 18, further comprising:

5 program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10 pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

input/output control means for receiving as an input said packet
15 output from said operating means, and outputting to the outside or to said
program storing means.

20. A data driven type information processing apparatus including
operating means receiving a packet having at least a destination field
storing destination information, an instruction field storing instruction
information and data field storing data, for executing an operation in
5 accordance with a data flow program using the received packet, wherein
said operating means has

filtering operation means for performing an operation in accordance
with a median filtering instruction instructing, where a plurality of local
areas including N pixel values of $K \times K$ (K is an odd number not smaller
10 than 3) are arranged overlapped with each other in a prescribed area of a
digitized image, calculation of a median of N pixel values of each of the
local areas, means for other operations, and branching means for
outputting, based on said instruction information of said received packet,
said received packet either to said filtering operation means or said means
15 for other operations;

said filtering operation means includes
receiving means for inputting pixel values of said prescribed area of
said data field of received said packet, and outputting, for each of said
plurality of local areas, a packet having N pixel values included in the local
20 area stored in the data field, and

median extracting means corresponding to each of said plurality of
local areas; and

said median extracting means includes
removing means, receiving from said receiving means a packet
25 storing N pixel values included in corresponding said local area, for
removing, from the input pixel values, $((N-1)/2)+2$ th to Nth pixel values as
sorted in accordance with a prescribed order, and

sorting means for extracting, among $(N-(N-1)/2)$ pixel values
remaining after removal of the pixel values by said removing means in the

30 data field of said packet, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median, storing the median in said data field of said packet and outputting the packet.

21. The data driven type information processing apparatus according to claim 20, wherein
said prescribed order is either ascending order or descending order.

22. The data driven type information processing apparatus according to claim 20, further comprising:

5 program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10 pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

15 input/output control means for receiving said packet output from said operating means, and outputting to the outside or to said program storing means.

23. A filtering method for calculating a median of N pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd number not smaller than 3) of a digitized image, comprising:

5 the receiving step of receiving said N pixel values;
the removing step of removing, from said N pixel values received in said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and
the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values

10 remaining after the removal of the pixel values in said removing step, first
pixel value as sorted in accordance with said prescribed order as said
median.

24. A filtering method for calculating a median of N pixel values
arranged in a two-dimensional area of $K \times K$ (K is an odd number not
smaller than 3) of a digitized image, comprising:

5 the receiving step of receiving said N pixel values;
the removing step of removing, from said N pixel values received in
said receiving step, $((N-1)/2)+2$ to N th pixel values as sorted in accordance
with a prescribed order; and

10 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values
remaining after removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as
said median.

25. A program product to have a computer execute a filtering
method, wherein

5 said filtering method is for calculating a median of N pixel values
arranged in a two-dimensional area of $K \times K$ (K is an odd number not
smaller than 3) of a digitized image, including:

the receiving step of receiving said N pixel values;
the removing step of removing, from said N pixel values received in
said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance
with a prescribed order; and

10 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values
remaining after removal of the pixel values in said removing step, first
pixel value as sorted in accordance with said prescribed order as said
median.

26. A program product to have a computer execute a filtering
method, wherein

said filtering method is for calculating a median of N pixel values

- 5 arranged in a two-dimensional area of $K \times K$ (K is an odd number not smaller than 3) of a digitized image, including:
- the receiving step of receiving said N pixel values;
 - the removing step of removing, from said N pixel values received in said receiving step, $((N-1)/2)+2$ to N th pixel values as sorted in accordance with a prescribed order; and
 - 10 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as said median.

27. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein
- said filtering method is for calculating a median of N pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd number not
- 5 smaller than 3) of a digitized image, including:
- the receiving step of receiving said N pixel values;
 - the removing step of removing, from said N pixel values received in said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and
 - 10 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

28. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein
- said filtering method is for calculating a median of N pixel values arranged in a two-dimensional area of $K \times K$ (K is an odd number not
- 5 smaller than 3) of a digitized image, including:
- the receiving step of receiving said N pixel values;
 - the removing step of removing, from said N pixel values received in said receiving step, $((N-1)/2)+2$ to N th pixel values as sorted in accordance

with a prescribed order; and

10 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.

29. A filtering method of calculating, where a plurality of areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, a median of N pixel values of each of the areas, comprising:

5 the receiving step of receiving the pixel values of said plurality of areas, and outputting, for each of said plurality of areas, N pixel values included in the area; and

the median extracting step of extracting the median corresponding to each of said plurality of areas; wherein

10 said median extracting step includes

the removing step of removing, from said N pixel values included in corresponding said area and received in said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and

15 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after the removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

30. A filtering method of calculating, where a plurality of local areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, comprising:

5 the receiving step of receiving the pixel values of said prescribed area, and outputting, for each of said plurality of local areas, N pixel values included in the local area; and

the median extracting step of extracting the median corresponding to

10 each of said plurality of local areas; wherein
said median extracting step includes
the removing step of removing, from said N pixel values included in
corresponding said local area and received in said receiving step, $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed
15 order; and
the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values
remaining after the removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as
said median.

31. A program product to have a computer execute a filtering
method, wherein

5 said filtering method is for calculating, where a plurality of areas
including N pixel values of $K \times K$ (K is an odd number not smaller than 3)
are arranged overlapped with each other in a digitized image, a median of
N pixel values of each of the local areas, including:

the receiving step of receiving the pixel values of said plurality of
areas, and outputting, for each of said plurality of areas, N pixel values
included in the area; and

10 the median extracting step of extracting the median corresponding to
each of said plurality of areas; wherein

said median extracting step includes

15 the removing step of removing, from said N pixel values included in
corresponding said area and received in said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and

the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values
remaining after the removal of the pixel values in said removing step, first
pixel value as sorted in accordance with said prescribed order, as said
median.

32. A program product to have a computer execute a filtering
method, wherein

said filtering method is for calculating, where a plurality of local areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, including:

the receiving step of receiving as inputs the pixel values of said prescribed area, and outputting, for each of said plurality of local areas, N pixel values included in the local area; and

the median extracting step of extracting the median corresponding to each of said plurality of local areas; wherein

said median extracting step includes

the removing step of removing, from said N pixel values included in corresponding said local area and received in said receiving step, $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed order; and

the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after the removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.

33. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein

said filtering method is for calculating, where a plurality of areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, a median of N pixel values of each of the areas, including:

the receiving step of receiving the pixel values of said plurality of areas, and outputting, for each of said plurality of areas, N pixel values included in the area; and

the median extracting step of extracting the median corresponding to each of said plurality of areas; wherein

said median extracting step includes

the removing step of removing, from said N pixel values included in

15 corresponding said area and received in said receiving step, first to $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and
the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after the removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

34. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein

5 said filtering method is for calculating, where a plurality of local areas including N pixel values of $K \times K$ (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, including:

10 the receiving step of receiving the pixel values of said prescribed area, and outputting, for each of said plurality of local areas, N pixel values included in the local area; and

the median extracting step of extracting the median corresponding to each of said plurality of local areas; wherein

said median extracting step includes

15 the removing step of removing, from said N pixel values included in corresponding said local area and received in said receiving step, $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed order; and

20 the sorting step of outputting, among the $(N-(N-1)/2)$ pixel values remaining after the removal of the pixel values in said removing step, $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.